



Physical Sciences

Multimode Directional Coupler for Utilization of Harmonic Frequencies From TWTAs

The design is easily scaled to higher frequency TWTAs.

John H. Glenn Research Center, Cleveland, Ohio

A novel waveguide multimode directional coupler (MDC) intended for the measurement and potential utilization of the second and higher order harmonic frequencies from high-power traveling wave tube amplifiers (TWTAs) has been successfully designed, fabricated, and tested. The design is based on the characteristic multiple propagation modes of the electrical and magnetic field components of electromagnetic waves in a rectangular waveguide.

The purpose was to create a rugged, easily constructed, more efficient waveguide-based MDC for extraction and exploitation of the second harmonic signal from the RF output of high-power TWTs used for space communications. The application would be a satellite-based beacon source needed for Q-band and V/W-band atmospheric propagation studies. The MDC could function as a CW narrow-band source or as a wideband source for study of atmospheric group delay effects on high-data-rate links.

The MDC is fabricated from two sections of waveguide — a primary one for the fundamental frequency and a secondary waveguide for the second harmonic — that are joined together such that the second harmonic higher order modes are selectively coupled via precision-machined slots for propagation in the secondary waveguide.

In the TWT output waveguide port, both the fundamental and the second harmonic signals are present. These signals propagate in the output waveguide as the dominant and higher order modes, respectively. By including an appropriate mode selective waveguide directional coupler, such as the MDC presented here at the output of the TWT, the power at the second harmonic can be sampled and amplified to the power level needed for atmospheric propagation studies.

The important conclusions from the preliminary test results for the multimode directional coupler are: (1) the second harmonic (Ka-band) can be measured and effectively separated from

the fundamental (Ku-band) with no coupling of the latter, (2) power losses in the fundamental frequency are negligible, and (3) the power level of the extracted second harmonic is sufficient for further amplification to power levels needed for practical applications. It was also demonstrated that third order and potentially higher order harmonics are measurable with this device. The design is frequency agnostic, and with the appropriate choice of waveguides, is easily scaled to higher frequency TWTs. The MDC has the same function but with a number of important advantages over the conventional diplexer.

This work was done by Rainee N. Simons and Edwin G. Wintucky of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-19045-1.

Dual-Polarization, Multi-Frequency Antenna Array for use with Hurricane Imaging Radiometer

New approach promises to be more cost effective and can reduce on-station aircraft time.

Marshall Space Flight Center, Alabama

Advancements in common aperture antenna technology were employed to utilize its proprietary genetic algorithm-based modeling tools in an effort to develop, build, and test a dual-polarization array for Hurricane Imaging Radiometer (HIRAD) applications. Final program results demonstrate the ability to achieve a lightweight, thin, higher-gain aperture that covers the desired spectral band.

NASA employs various passive microwave and millimeter-wave instruments, such as spectral radiometers, for a range of remote sensing applications, from meas-

urements of the Earth's surface and atmosphere, to cosmic background emission. These instruments such as the HIRAD, SFMR (Stepped Frequency Microwave Radiometer), and LRR (Lightweight Rainfall Radiometer), provide unique data accumulation capabilities for observing sea surface wind, temperature, and rainfall, and significantly enhance the understanding and predictability of hurricane intensity. These microwave instruments require extremely efficient wideband or multiband antennas in order to conserve space on the airborne platform.

In addition, the thickness and weight of the antenna arrays is of paramount importance in reducing platform drag, permitting greater time on station.

Current sensors are often heavy, single-polarization, or limited in frequency coverage. The ideal wideband antenna will have reduced size, weight, and profile (a conformal construct) without sacrificing optimum performance. The technology applied to this new HIRAD array will allow NASA, NOAA, and other users to gather information related to hurricanes and other tropical storms